

The ISO New England Long-Run Forecast of Net Energy For Load

A ten-year forecast of the ISO New England Control Area and New England state energy for the 2008 Forecast Report of Capacity, Energy, Loads and Transmission (CELT)

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The April 2008 Long-Run ISO-NE Control Area Energy Forecast

The Long-Run forecast of the ISO-NE Control Area Net Energy for Load (NEL) is a forecast of ten years of energy growth by each of the six New England states. The sum of the states is totaled and reconciled to the Short-Run NEL Forecast for the first two years. The adjustments made in the last short run-year are applied to the long-run years.

The April 2008 or 4/08 Forecast refers to the date of the April 1, 2008 ISO-NE Control Area Forecast Report of Capacity, Energy, Loads and Transmission (CELT) for which this forecast is produced.

This year a new energy model for each of the States was developed. The structure of the model is the same as in the energy model for the ISO-NE Control Area. The Compound Annual Growth Rate (CAGR) over the forecast period from 2008 to 2017 for long-run regional energy is: 0.8%. This number is lower when comparing with last year compound growth rate. The lower forecast growth rate for income in each of the states account for that decrease.

Long-Run Net Energy for Load Forecast

The table below shows the projected annual energy and annual growth rates for the long-run forecast for the ISO-NE Control Area.

		Regional	Annual
Weather	YEAR	GWh	Growth
Normal:	2007	133360	---
<i>Forecast:</i>	2008	135000	1.1%
	2009	136540	1.1%
	2010	137885	1.0%
	2011	139195	1.0%
	2012	140425	0.9%
	2013	141550	0.8%
	2014	142565	0.7%
	2015	143500	0.7%
	2016	144395	0.6%
	2017	145275	0.6%

Forecast values for annual energy and seasonal peaks by state (including the high and low bandwidths) and the state to ISO-NE adjustments can be found in the "Forecast Data 2008" file on ISO-NE's website at: http://www.iso-ne.com/trans/ceft/fsct_detail/ .

Forecast Methodology & Assumptions

Description of the model:

The 4/08 long-run energy model is an annual model of total energy for each of the New England states. An autoregressive model, using lags on the dependent variable, in conjunction with economic and demographic variables, was used to forecast state energy growth. Real personal income, real price of electricity and weather variables are used as the explanatory variables. This dynamic specification allows for the gradual adjustment of energy consumption to changes in the explanatory variables. The model produces both short-run and long-run income and price elasticities based on the fit to historical data. In the majority of the models, a flexible short-run and long-run price elasticity was statistically significant and therefore kept in the model. In those cases, the price elasticity changes over time and becomes less inelastic as time pass by. A higher energy response to prices could reflect the increasing impact of conservation on energy or switch to more energy efficient appliances due to higher energy prices. As in last year's forecast, DSM effects are no longer explicitly incorporated into the state models, but are considered to be embedded within the historical data and the subsequent forecast.

For each of the state energy models, ISO-NE uses the sample size that gives more stable estimates. The use of a shorter sample size is called "truncation of the sample". Truncations could be necessary under special circumstances. An example of truncation would be the case of Vermont. Between 1980 and 1986, the electric price and energy moved in opposite direction. The model could not identify a negative statistically significant price estimate for the entire sample (see appendix, graph energy vs real price). ISO-NE used a sample size of 1987-2007. Other researchers have faced the same problem and even find positive price elasticity for the state. (see Technical Report: Differences in the price-elasticity of demand for energy by Mark A. Bernstein, James Griffin and prepared for the National Renewable Energy Laboratory). By truncating the series, ISO-NE was able to achieve statistically significant price elasticities.

ISO-NE state energy models include dummy variables to account for extraordinary events that affect the level of energy and are not caused by the explanatory variables in the model. For example, the energy model of Maine includes several dummies to account for the "jumps" or sudden increases in the level of energy corresponding to the incorporation of generation to the grid. Those sudden increases in energy occurred at the end of the 90s and at the beginning of the 2000's. The use of dummies is to reinforce the coefficient of the lag dependable variable for 1999, 2000 and 2001. In the same fashion, the model includes point dummies in 1995 and 1998 to account for the negative growth of energy in both years despite the decrease in prices and increase in real income.

Changes from 2007 to 2008:

For the 2008 forecast cycle, the ISO made several changes in the forecast methodology: (1) use an autoregressive model with one lag of total energy as explanatory variable for each of the state energy models; (2) used real personal income in each of the state energy models and not the real disposable income or Gross state product; (3) included weather variables except for Maine; (4) included real electricity price variable in the Vermont model; (5) updated the historical data through 2007; (6) expressed the variables in natural logarithmic; and (7) used average all class of service electricity prices rather than just residential.

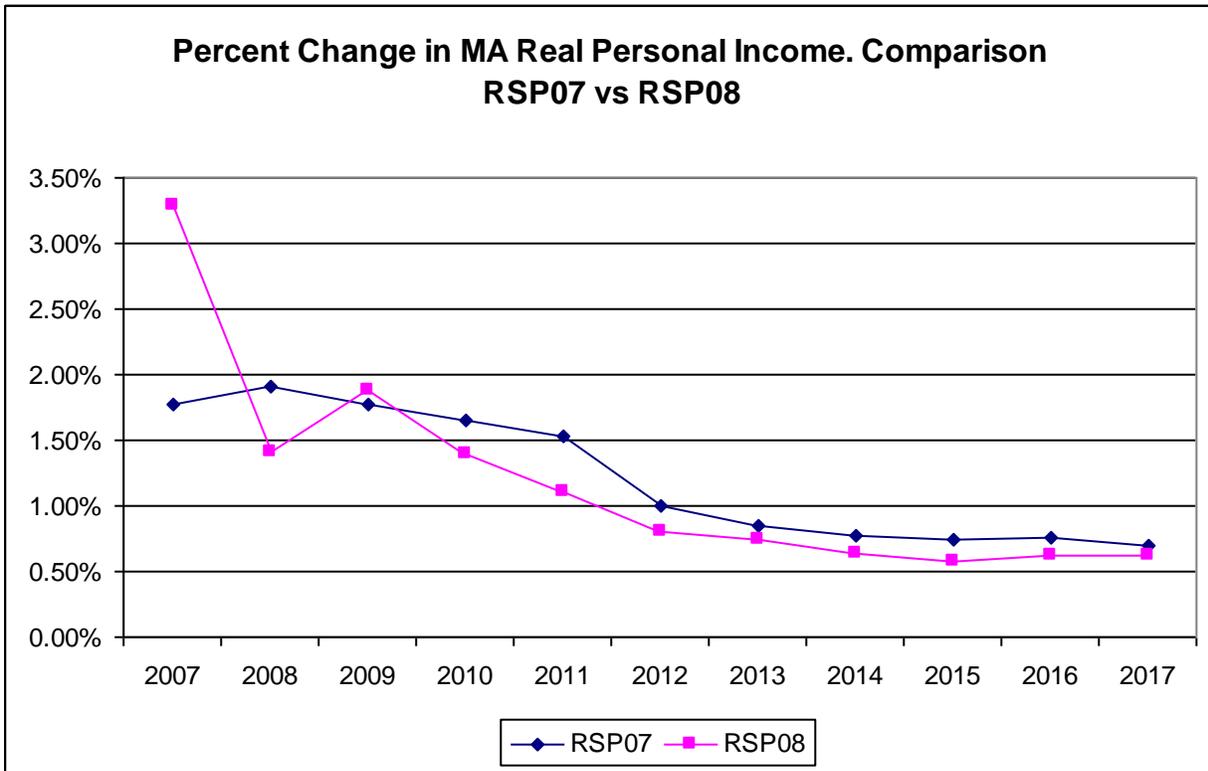
Forecast assumptions:

Economic and demographic drivers used in the Long-Run Energy Forecast are:

- Real Personal Income by State - from a forecast of state-by-state Nominal Income deflated by a blended forecast of the US and Boston CPI from Economy.com.
- New England Real Electric Price (Total) - derived from the Energy Information Administration's Current and Historical Monthly Sales, Revenue and Average Revenue per Kilowatt-hour by State and by Sector. See http://www.eia.doe.gov/cneaf/electricity/page/sales_revenue.xls for more information.

Real personal Income was used as a driver in the six state models. Since Massachusetts has the region's largest population, over 45% of the New England total, its drivers have a substantial effect on the regional energy forecast. For this reason, the chart below shows a comparison of percent change in Real Personal Income used in the 2008 Massachusetts forecast (RSP08) vs. the value from the 2007 forecast (RSP07).

As the chart reveals, the rate of change in growth of real personal income for Massachusetts is different for the two data streams. IN 2008, the growth rate has slow down explaining the long-run lower forecast growth versus last year.



Real Retail Electric Price

The real electricity-price forecast for 2008 to 2017 assumes that increases will be held to the rate of inflation (2.5% average annual growth) and will incorporate the assumed transition costs from the FCM Settlement Agreement and assumed capacity costs from the Forward Capacity Market (\$1.9 billion in 2010, increasing to \$2.5 billion in 2017). The assumed capacity costs of the FCM are based on RSP07’s projected system-wide installed capacity (ICAP) requirements and an assumed capacity clearing price of \$4.75/kW-month after adjustments for peak-energy rent. This is the same method used in RSP07, the only difference is that the actual increase in 2007 was lower than forecasted last year.

2008 Long-Run Energy Forecast Methodology for State Models

The state-level energy models are based on a linear dynamic regression of state-level energy against a set of explanatory variables that include the one-period lag of energy, real personal income, real price of electricity, and degree days. EViews econometric software was used to estimate and forecast the energy models. The detailed output produced by the software, results from the statistical tests used to evaluate the model and the forecast evaluation are shown in the spreadsheet file at the link “Forecast Energy Models 2008.” Least Squared Estimation was used to estimate all the models. All the energy models are in double log form. Double log models are the most standard

functional form chosen to forecast energy and have the advantage of estimating directly the price and income elasticities. The models produce short-run and long-run price elasticities.

The short-run price elasticities range from -0.02% (Vermont) to -0.09% (Maine). The long-run price elasticities range from -0.02% (Vermont) to -0.15% (Connecticut, Rhode Island, and New Hampshire). Short-run income elasticities vary from 0.23% (Rhode Island) to 0.55% (Maine); Long-run income elasticities range from 0.48% (Vermont) to 0.69% (Massachusetts).

Overall, the state-level energy models exhibit very good statistical properties. All the estimates of the explanatory variables have the expected signs and are statistically significant at 1% critical level. The overall goodness of fit is represented by the high adjusted R-squared ranging from 0.96 for the Vermont energy model to 0.99 for the rest of the state models.

As ISO-NE deals with time series data, the most typical statistical problem the models encounter is serial autocorrelation of order 1, or higher, in the residuals. Having residuals of different periods correlated would indicate the failure of the model to fully explain the pattern in the data. In this case, the standard warning is that the regression estimates from an ordinary least squares regression are still unbiased, but the standard errors and confidence intervals estimated by conventional procedures will be too narrow, giving a false sense of precision.

ISO-NE modeled energy until the residuals from the model exhibited no pattern (white noise). Further, ISO-NE used the Breusch-Godfrey Lagrange multiplier test to test for serial autocorrelation of order 1. Correlogram of the residuals and the Ljung-Box Q-statistics associated with it were used to test for “n” order serial autocorrelation (or White noise). As all the p-values are larger than 0.05, the tests fail to reject the null hypothesis of no serial autocorrelation in each of the state-level energy models.

Consequences of a non-constant variance of the residuals have the same implications on the estimates and their standard deviation as in the case of serial autocorrelation. Thus, ISO-NE also tested for white heteroskedasticity and autoregressive conditional heteroskedasticity in the residual using the white heteroskedasticity test and the ARCH Lagrange multiplier test, respectively. In both cases, p-values are larger than 0.05 so that we fail to reject the null hypothesis of homokedasticity (constant variance of the residuals).

We have tested for non-stationarity (or also called “unit roots”) in the series using the Augmented Dickey-Fuller test. As expected, tests indicate that energy, income and prices are non-stationary series while the weather variables (HDD and CDD) are stationary. Thus, to make sure that the relationship between energy, income and price stated in the models is not spurious, when modeling we aim for a set of estimates whose linear combination was stationary. Thus, we tested the residuals of the final models for non-stationarity as well. In each of the models, Augmented Dickey-Fuller test rejected the null hypothesis of unit root with a probability under 0.0022.

The forecast evaluation was done by using the mean absolute percentage error (MAPE), mean proportion, variance proportion and the covariance proportion. Mean proportion tells how far the mean of the forecast is from the mean of the actual series. The forecast model should target a mean proportion as small as possible, close to zero. The variance proportion tells how far the variation of the forecast is from the variation of the actual series. A forecast model should target a variance proportion as small as possible, close to zero. The covariance proportion measures the imperfect or incomplete co-variation between forecast and actual series. Ideally, the covariance proportion should be close to one. All the models produce very good statistics as the MAPE ranges from 0.51% (Vermont) to 0.79% (New Hampshire), the mean and variance proportion are very close to zero and the covariance proportion is close to one in all the cases. These results reinforce the robustness of the models.

2008 Forecast: High/Low Economic Bandwidths

High and Low economic scenarios are created for the long-run regional energy forecast by regressing the same drivers high and low economic forecasts (from Economy.com) and adjusting electricity prices upward or downward over the forecast. The low growth scenario includes prices increasing annually at the rate of the weighted CPI from the baseline values. For the high growth scenario, prices are reduced annually at the rate of the weighted CPI to help simulate a systematic reduction in energy costs.

The High and Low energy and peak forecasts are developed using the same methodology as the reference case energy and peak forecasts.

